Project H-3. Sodium Borohydride as a Hydrogen Storage Material

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Sodium borohydride ($NaBH_4$, SBH) contains 10.6 mass% of hydrogen and its aqueous solution is applicable both as the source of gaseous hydrogen (H_2) and protide (H^-) in fuel cell applications. However, it must be pointed out that its practically available H-content reduces to 3-5 wt.% by water dilution.

We have developed the following technologies related to the application of aqueous SBH solution during the last 5 years' efforts in IEA HIA TASK 17;

(1) New processes for the production of SBH based on the principle of protide transformation at the extreme surface on such catalysts as Mg and Al and sodium metaborate ($NaBO_2$) particles under hydrogen atmosphere. These processes apply borax ($NaBO_2 \bullet 4H_2O$) as the natural resource and borate ($Na_2B_4O_7 \bullet 10H_2O$) as "Spent fuel". (*Funded by JR Research Center: 2001 to present*)

(2) A new fuel cell named "Direct Borohydride Fuel Cell (DBFC)" has been developed, which applies aqueous SBH solutions as the source of protide (H^-) and generates 2 electrons per H^- and 8 electrons per borohydride complex ion (BH_4^-). This fuel cell generates 1.64 volts per cell under ambient pressure and temperature conditions. In DBFC, a new series of Ti-based alloys for anode and Ni-based alloys for cathode has been developed in replacement with Pt-based catalysts. (*Funded by JST: FY2002 and by NEDO: FY2003 – FY2005, and an international cooperative project: with 3 companies: 2003 to present*)

(3) Catalytic hydrolysis to generate gaseous hydrogen for Polymer Electrolyte Membrane Fuel Cell (PEMFC), where a series of Mg-based and Ni-based catalysts were developed as a cooperative R&D project with 4 companies and 2 universities): (*Funded by NEDO: FY2000 – FY2001*)

(4) Gaseous hydrogen generated by the catalytic hydrolysis was successfully applied for a compact series of PEMFC named "SuperPEM". Presently, this system has been developed as a power source for emergency uses (100W – 1kW) and battery chargers for small electronic devices such as laptop computers (40W – 80W). (*An international cooperative project since 2005*)

We will initiate an international cooperative R&D project for the development of Na and B based H-storage materials as our next effort in a new IEA Annex project that will be started after TASK 17.